MANAGEMENT OF CHRONIC POSTEROLATERAL INSTABILITY OF THE KNEE: OPERATIVE TECHNIQUE FOR THE POSTEROLATERAL CORNER SLING PROCEDURE

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The term posterolateral rotatory instability (PLRI) of the knee describes a spectrum of pathologic states of ligamentous laxity in which the lateral tibial plateau subluxates posterior to the lateral femoral condyle when an external rotational force is applied to the knee (Figure 1). When the point of subluxation is reached, the patient will recognize the associated weakness and posterolateral pain. In its mildest form, it is merely a physical exam finding of a gliding motion which is determined to be excessive only when it is compared to the patient's opposite side. When a clinically significant degree of laxity exists, the examiner can hold the foot in external rotation, apply valgus pressure and move the knee from a fully extended position into 20 or 30 degrees of flexion to demonstrate the subluxation. This subluxation will often present as the sudden translational acceleration of the tibia on the femur that the patient associates with episodes of giving way and that we know as a reverse pivot-shift phenomenon. Further flexion with the leg in valgus and external rotation will increase the patient's complaint of pain and weakness in the posterolateral corner of the knee.

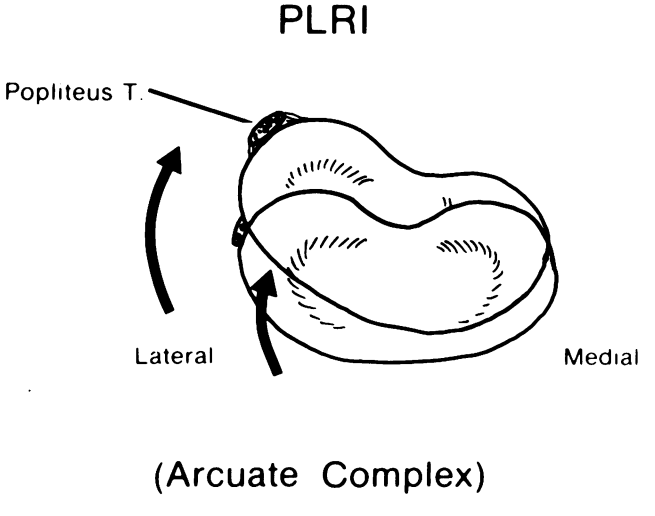

Figure 1
Top view of pathologic posterior displacement of the lateral tibial plateau on the lateral femoral condyle with laxity of the arcuate complex.

Anatomically, PLRI and the reverse pivot-shift episodes are associated with injury to the structures at the posterolateral corner of the knee, known collectively as the arcuate complex. The arcuate complex consists of the arcuate ligament, popliteus tendon, the lateral head of the gastrocnemius, lateral collateral ligament, and the joint capsule. Clinically, functional instability is known to result either acutely from hyperextension-varus injuries; or gradually, associated with other ligament injury patterns. Patients with mild PLRI present with an insidiously developing entity which is commonly overlooked on physical examination. Patients with the most severe degree of laxity present a dramatic clinical picture where violent and painful pivot-shift subluxations are experienced with every step. It is this severe chronic state that is known to be most difficult to correct surgically.

In the late 1970's, a novel soft tissue procedure named the **"posterolateral corner sling procedure"** (PLCS), was developed that has, in my experience, proven to be a very reliable method for eliminating PLRI and the reverse pivot-shift phenomenon. The results of an outcome study of this surgery have been presented recently[1]. With the results-oriented article committed to publication elsewhere, the purpose of this paper is to describe the operative technique of the PLCS procedure. The procedure involves creation of an extraarticular sling that extends from a point on the posterior tibia, immediately medial to the proximal tibio-fibular articulation, anteriorly and superiorly to an isometric point on the femur.

PREOPERATIVE EVALUATION AND OPERATIVE PLANNING

In isolated cases of severe arcuate complex pathology the following clinical findings are usually present; varus laxity, a positive dial test at 30 and 70 degrees of flexion, a posterior lateral drawer test, and a reverse pivot-shift. The degree of direct lateral laxity due to lateral collateral ligament (LCL) deficiency must be carefully evaluated because a separate surgical correction may also be required. The presence of intraarticular pathology is highly likely. It should be documented and treated arthroscopically prior to the extra-capsular dissection. The coexistence of other planes of instability is also quite frequent. In my experience, the most frequent ligamentous deficiency

to accompany PLRI is anterior cruciate ligament (ACL) deficiency with anterolateral rotatory instability (ALRI). Less frequently posterior cruciate ligament (PCL) deficiency with direct posterior laxity is present. The combination of PCL and the arcuate ligament complex insufficiency makes for the most dramatic findings on dial and reverse pivot shift testing. The dial test is then likely to be greater at 70 degrees than at 30 degrees.

In any case of multidirectional instability of the knee, it is recommended that surgical correction of each component of instability be planned preoperatively. This is particularly important for estimating the duration of the entire operation and in judicious use of the tourniquet. Diagnostic arthroscopy and the PLCS procedure can be accomplished together in under two hours. However, each additional finding that requires surgical correction will add to the total length of the case. For instance, when an ACL reconstruction with patellar tendon autograft, a single meniscus excision/repair and an LCL reconstruction are added to the above two step procedure, a target time of 5 hours should be anticipated. In this instance, a split surgical team approach could be used to cut down operative time.

DESCRIPTION OF OPERATIVE PROCEDURE

The approach

With the knee flexed 45 degrees, the skin incision courses from just distal to Gerdy's tubercle (Figure 2), along the iliotibial band (ITB) onto the mid-lateral aspect of the distal thigh. Before the posterolateral corner is dissected it is important to identify and protect the peroneal nerve. It is most readily identified three finger breadths below the fibular head where it becomes superficial as it wraps around the fibula (Figure 2). Maintenance of the knee in a flexed position keeps the nerve out of the operative field during the procedure described below. The most important anatomical structures that need to be exposed for this approach are best located by first identifying the LCL from its femoral to its fibular attachment (Figure 3). Lying immediately posterior to the LCL is the tendinous portion of the lateral head of the gastrocnemius. The plane between the tendon of the lateral head of the gastrocnemius (Figure 4) and the LCL is developed from the femoral insertions to 2-3 cm below the lateral joint line. The gastrocnemius is retracted posteriorly to expose the structures deep to it. Careful dissection is then carried out in order to identify the capsule and the popliteus tendon.

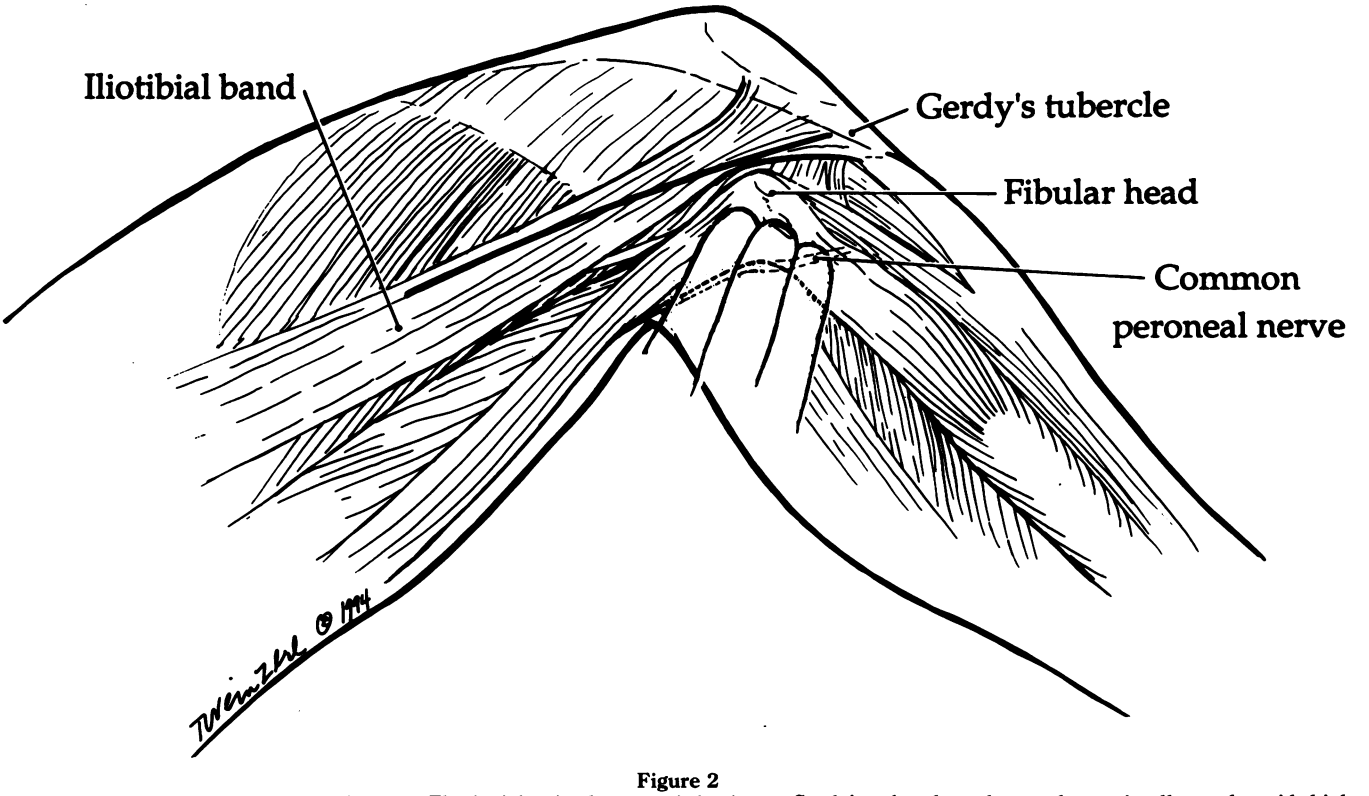

Figure 2

Lateral view of knee flexed 70-80 degrees. The incision is shown as it begins at Gerdy's tubercle and extends proximally up the mid thigh region. The location peroneal nerve can be identified as it becomes superficial to the fibular shaft approximately 3 finger breadths from the fibular head.

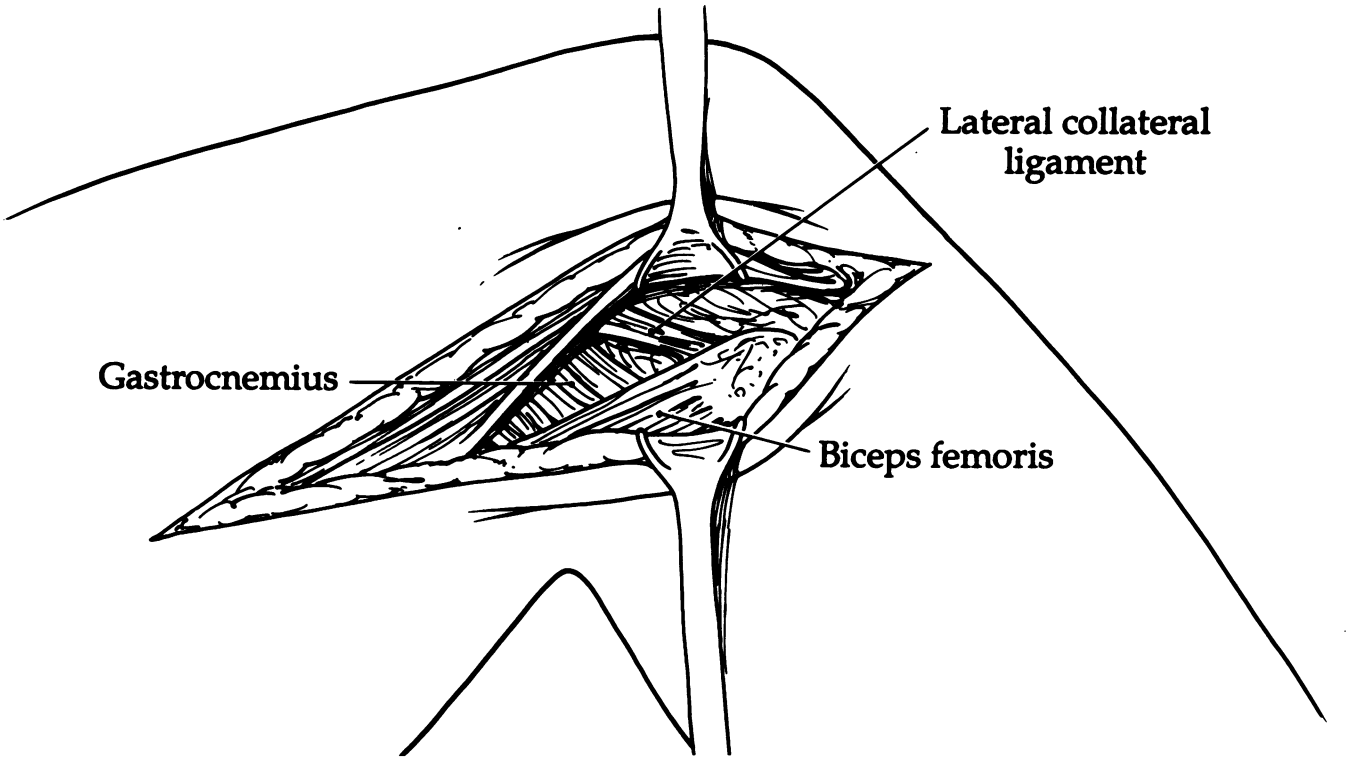

Figure 3
Beneath the ITB the LCL and the tendinous portion of the lateral head of the gastrocnemius lie adjacent to each other.

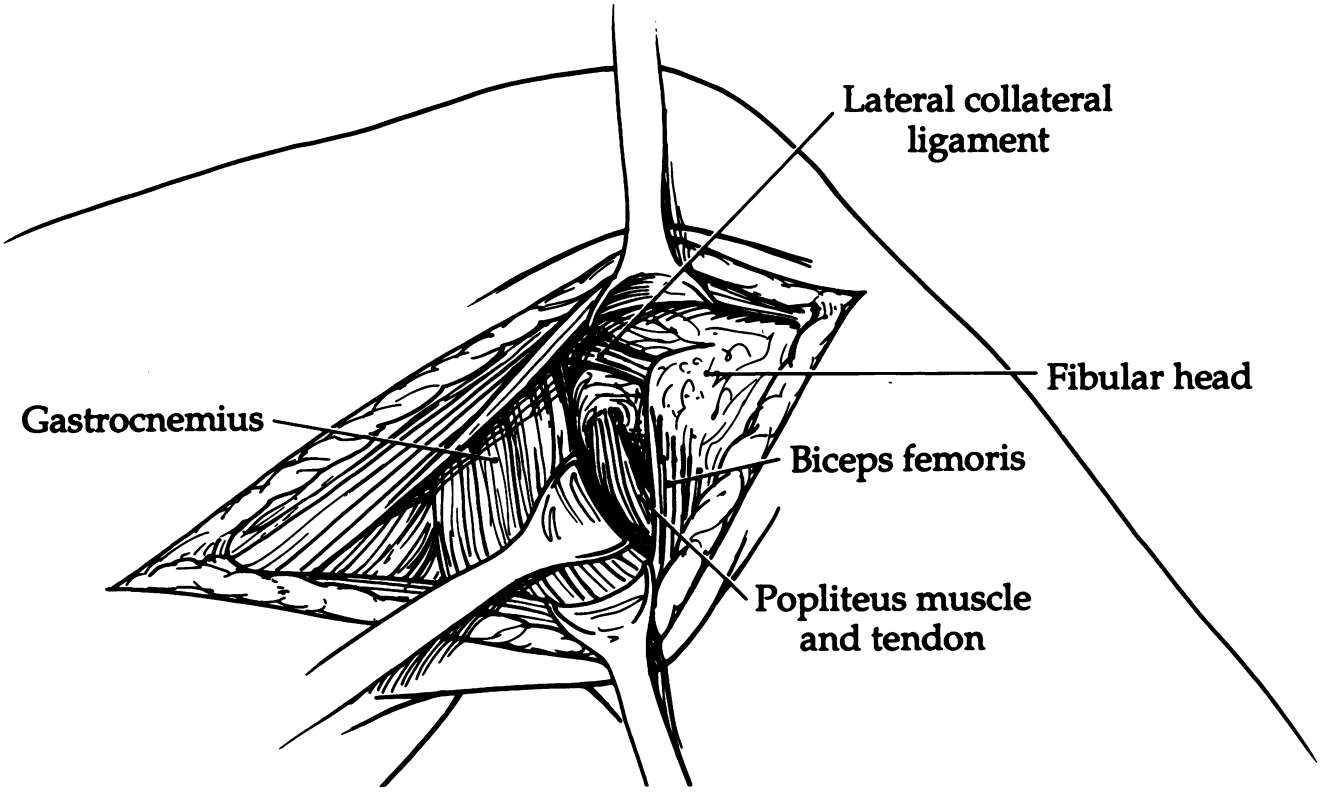

Figure 4
When the gastrocnemius is retracted, the popliteus can be found coursing obliquely. The muscle originates on the posterior aspect of the proximal tibia and inserts on the femur just inferior and anterior to the LCL.

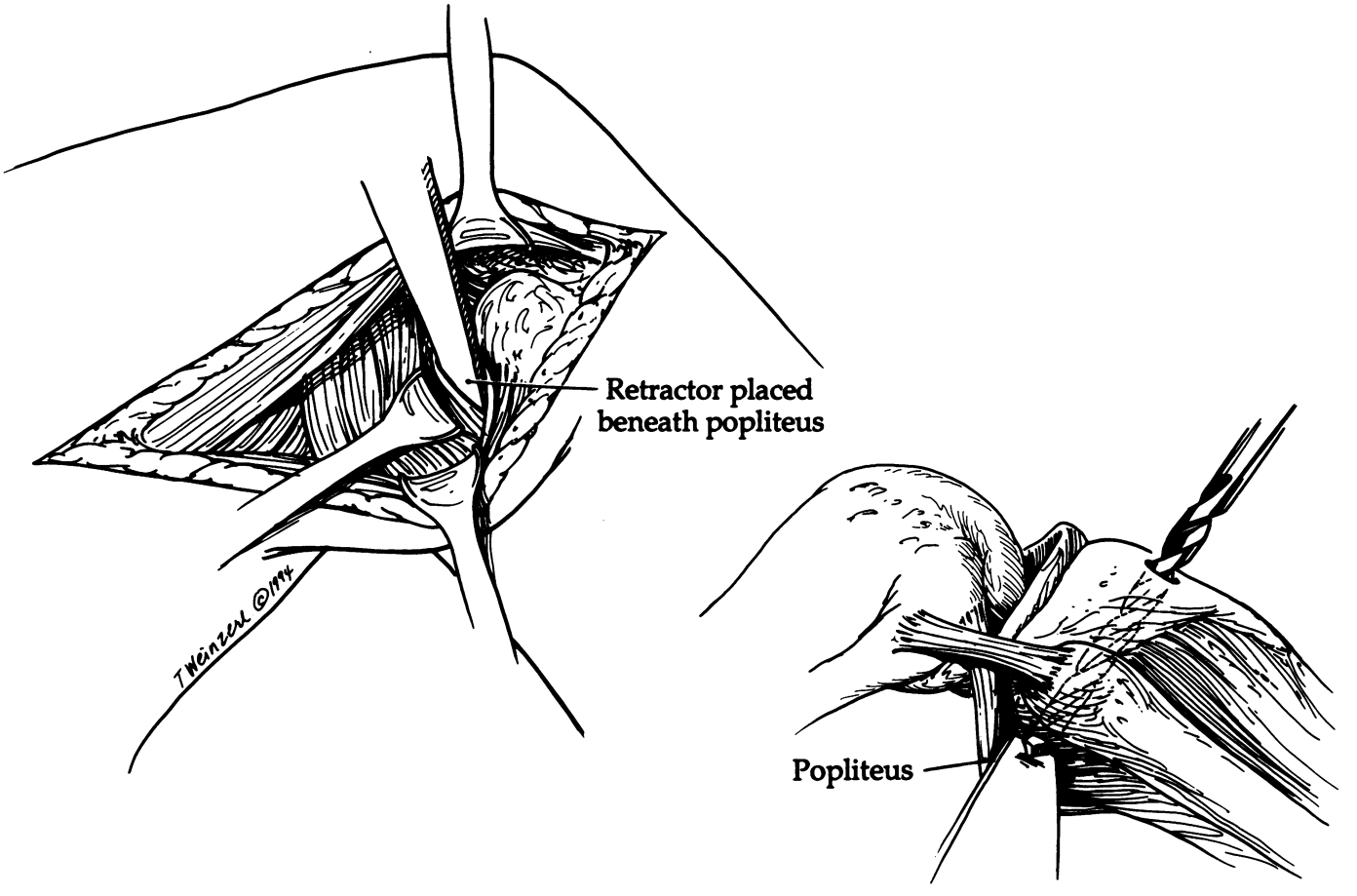

Figure 5
Once the popliteus is mobilized posteriorly, a retractor is inserted to expose the site where the tunnel will exit.

The popliteus tendon should be clearly delineated as it courses obliquely across this interval. In the deep portion of the wound it fans out as a wide muscle belly to its origin on the posterior aspect at the tibia distal to the capsule. The popliteus tendon disappears near the joint line as it dives deep to a thickening in the capsule, the popliteal foramen. This can be observed from above during the arthroscopic inspection of the lateral gutter and the posterior corner of the lateral meniscus. If help is needed to locate of the popliteus tendon, it is most readily visualized from the top of the foramen through a vertical incision into the joint capsule at the anterior edge of the LCL. The narrowest of the Cave retractors (or a hemostat) can then be passed retrograde through the foramen to help identify the course of the tendon in the area of interest. Once having identified the portion of the tendon inferior to the joint line, an incision is made along its anterior border and then the entire tendon is bluntly freed from the adjacent tissues. This maneuver is continued until the popliteus can be swept posteriorly enough to expose the posterior lateral corner of the tibia.

The Tunnel

A retractor is then placed beneath the popliteus to identify the target area on the tibia and to serve as a soft tissue protector from the exiting drill while the tunnel is being created (Figure 5). With the posterior tibia exposed, a 3/32 guide pin is passed from near Gerdy's tubercle to the desired point on the exposed tibia. The pin should exit at least 1-1.5 cm beneath the articular surface of the lateral tibial plateau and at least 1 cm medial to the proximal tibio-fibular articulation (Figure 6). This placement may be accomplished free hand or with the help of one of the latest large arc versions of the tibial guides available for endoscopic ACL reconstruction. Having achieved proper guide pin placement, a 6-8 mm diameter tunnel is established with a cannulated drill. The size of the tunnel depends on the size of the patient as well as of the graft but usually is 6, 7, or 8 mm in diameter. The location of the anterior starting point of the tunnel must be sufficiently inferior to the tibial articular surface and medial to the tibio-fibular joint to avoid compromising their integrity. If it is necessary to incorporate an anterior Losee type extracapsular sling to help control ALRI (due to a concomitant ACL deficiency) the starting point should be at, or slightly medial to, Gerdy's tubercle.

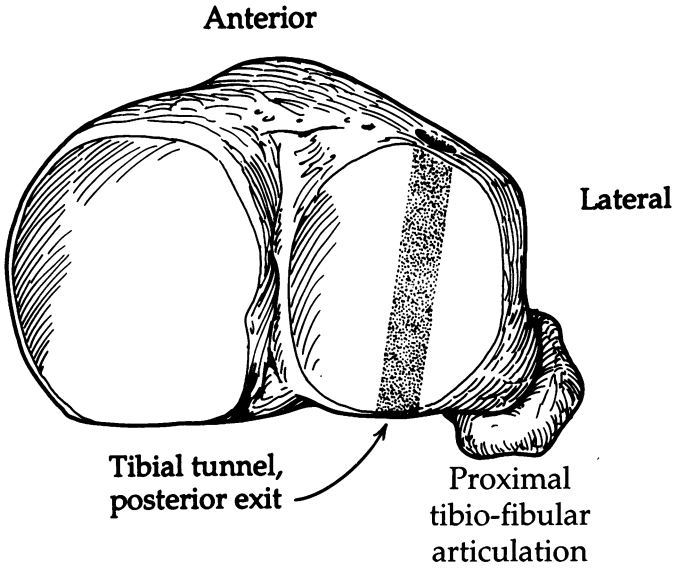

Figure 6
Superior view of the tibia to illustrate relationship of tunnel to proximal tibio-fibular joint. When using an ITB autograft, the anterior aspect of the tunnel should be in line with Gerdy's tubercle as shown here. When the PLCS is to be combined with a Losee type anterior sling, the entry portal should be medial to Gerdy's tubercle the interval between the tubercle and the patellar tendon.

The Graft

Allografts and autografts have proven successful for this procedure. Freeze dried and fresh frozen (and irradiated) ITB and Achilles tendon allografts have been used. At least at the time of implantation, fresh frozen tissue is notably stronger than the freeze dried grafts. Among the allografts, Achilles tendons are the easiest to work with and probably the stronger of the two alternatives. For autografts, the central slip of the ITB is the most convenient to use because of both its length and its attachment to Gerdy's tubercle. If ITB autograft is being used, care must be taken to make sure that sufficient length of graft is harvested. While usually around 18 cm, an accurate estimate of the length needed can be made by running a suture through the tunnel and up to the proposed femoral attachment site. If an ITB or Achilles tendon allograft is used, anterior tibial fixation must be achieved prior to searching for and securing the isometric femoral attachment.

Creating the Sling

The extracapsular posterolateral corner sling is created by passing a graft through the tibial tunnel from front to back with lead end anchor sutures and suture passers. The graft then exits its bony tunnel to emerge anterior to the lateral head of the gastrocnemius and popliteal tendon (Figure 7). From this point, the graft runs to a point on the

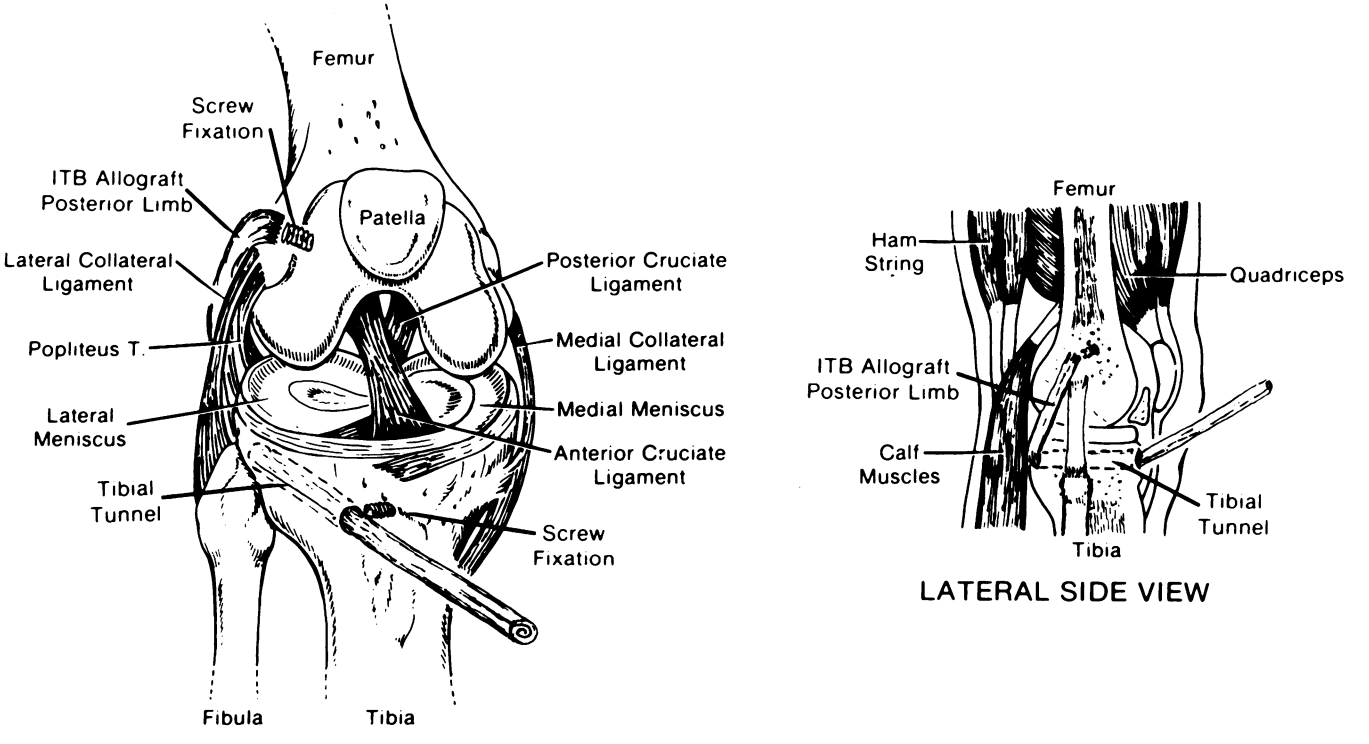

Figure 7
The posterior sling is accomplished by passing the graft from anterior to posterior in the tunnel. (Shown here is an allograft which must first be fixed to the tibia.) The posterior limb that exits the tunnel is brought up to an isometric point on the femur.

femur that will prevent pathologic posterior subluxation of the lateral tibial plateau in an isometric fashion. This isometric point is located by placing a Steinman pin slightly superior and anterior to the femoral attachment of the lateral collateral ligament. The proposed graft placement site is then tested for isometry by first placing the knee at 90 degrees of flexion, rotating the foot 10-15 degrees internally and then tensioning the soft tissue unit over the Steinman pin locator.

Placement Testing

Two tests are performed. The first test is performed by maintaining the internal rotation of the foot while the knee is run through a complete range of flexion and extension. Successful placement will result in equal tension of the graft throughout a complete range of motion from at least 0 to 120 degrees of flexion. In the second test, the thigh is supported and the knee is flexed to the degree (usually at least 45 degrees of flexion) that produced the most dramatic reverse pivot-shift preoperatively. By grasping the foot (without varus stress) the reverse pivot shift phenomenon is recreated when there is no tension placed on the PLCS graft. Tightening the graft should eliminate the posterior subluxation. This test can be repeated throughout the entire range of flexion. Care must be taken to make sure that any varus laxity from lateral joint line opening is taken up in the tensioning process.

Considerations in the presence of complex multidirectional laxity: ACL Deficiency with ALRI

Most frequently PLRI is seen in conjunction with ACL deficiency and ALRI. In this situation, concomitant intraarticular reconstruction of the ACL is imperative. This can be accomplished in any manner the surgeon wishes. Even an over-the-top graft should not preclude anchoring the extra capsular sling on the lateral femoral condyle. If the ACL tunnel is to exit on the lateral femoral cortex, then care should be taken to insure that it is located as high as possible above the flair of the distal femoral metaphysis. This is particularly important to avoid a conflict between the ACL graft tunnel location and the screw fixation of the PLCS.

Until the arthroscopically assisted intraarticular ACL reconstruction is completed, it is particularly important to maintain a water-tight joint by avoiding any incisions into the lateral capsule. Because it is difficult to establish a neutral point for the lateral compartment in the presence of both anterior and posterior lateral rotary instability, the manner in which the grafts are tightened is critical. It is my experience that the best way to find this neutral tibiofemoral relationship is to achieve ACL graft fixation first with the knee held in full extension. This should be accomplished without varus deformity and in neutral to very slight external rotation. Once the proper positioning and graft tension are identified in this position, the knee is

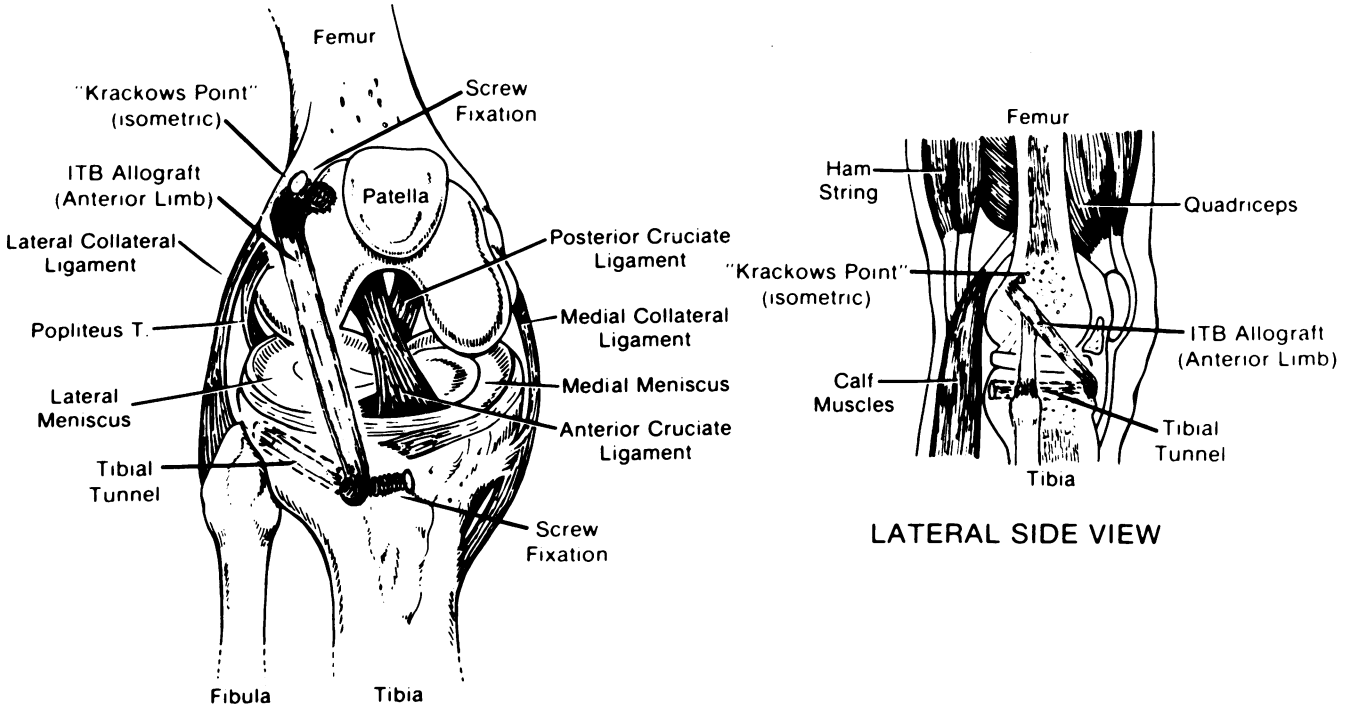

Figure 8
If an anterior extracapsular sling is needed to help control ALRI, the anterior limb of the allograft is taken back to Krachow's point.

maintained in the same rotation as the knee joint is flexed to about 20 degrees and the graft is tightened and secured with interference screws. Once having achieved this fixation, the PLCS procedure can be tensioned against the ACL.

If an allograft is being used for the PLCS and a Losee type extracapsular reinforcement of the ACL reconstriction is desired, an anterior extracapsular sling is run from the anterior tibial tunnel exit to a point near Krackow's isometric point on the femoral condyle (Figure 8). This sling is secured after the PLCS has been secured. The isometric point is also located with and tested over a Steinman pin. However, in this situation, neutral and even slight external rotation is maintained throughout the range of motion. Krackow's point was described as isometric in relationship to the ITB attachment at Gerdy's tubercle. It is located posterior to the femoral attachment of the LCL and near the gastroc tendon. More specifically, it is usually found to be 1 cm distal and posterior to the septum for the lateral thigh.

Varus Laxity

If varus laxity presents a significant problem, attention should also be directed to the fibular collateral ligament. Unless there is extreme varus alignment, soft tissue reconstruction should be successful obviating the need for a tibial osteotomy. If the ligament is intact but just lax, it is tightened by the proximal advancement of its femoral attachment on a cortical bone block. If there is insufficient LCL tissue or if there is a need for augmentation of an acutely ruptured ligament, this can be accomplished in one of two ways. First, as described by Clancy, all or part of the biceps tendon can be left attached to the fibula and dissected proximally after the peroneal nerve has been identified at its posterior border. The tendon is then screwed to the femoral origin of the LCL. Another alternative to this reconstruction is to use an Achilles tendon allograft. This method first involves the shaping of a tapered 6-7 mm bone plug cylinder from the calcaneous. This is such a small bone plug that shaping with a Midas Rex bur is recommended over the use of rongeurs in order to avoid shattering the bone. A taper is designed with the narrow end at the tendon attachment and the wider diameter located at the calcaneal end. This graft is then run from front to back through a tapered tunnel in the fibular head (of 6 tapering to 5 mm) that runs parallel to the lateral knee joint line. The proximal portion is then fixed over a soft tissue screw and washer at the LCL femoral attachment.

PCL Deficiency with Posterior Laxity

Similar to the situation of ACL deficiency, the PCL should be reconstructed prior to the PLCS procedure. The most difficult situation I have dealt with yet has involved both ACL and PCL deficiency as well as medial collateral ligament (MCL) and LCL laxity. Simultaneous tightening of both cruciate constructs with repeated testing of AP laxity is a critical first step. The PLRI and varus components can be addressed only after intraarticular stability has been achieved.

POSTOPERATIVE MANAGEMENT

Postoperative management should be individualized, but the plan should generally include a moderate early range of motion (e.g., 0-90), protection from external rotation and avoidance of varus stress for at least 6-8 weeks. This includes keeping the patient non-weight bearing if there is varus alignment. Often, a cast brace is indicated to maximize rotational and medial-lateral control during this critical period. A functional knee brace with straps placed in a manner similar to those used for the posterior cruciate reconstructions and a lateral heel and sole wedge are prescribed for use at 6-8 weeks postoperatively. Progress should be cautious. The patient must be warned that any loosening may mean that they go back into a cast. A 9-12 month rehabilitation time period is anticipated.

BIBLIOGRAPHY

[1.] Albright J.P., Dodds, J.A., Tearse, D.S.: Chronic Posterolateral Instability of the Knee: Evaluation of the Posterolateral Corner Sling Procedure, 106th Annual Meeting, American Orthopaedic Society for Sports Medicine, July 12-15, Sun Valley, Idaho.